

GENERAL DESCRIPTION

OB3652x is primary side control offline LED lighting power switch with very low operation current which can achieve accurate LED current for an isolated lighting application in a single stage converter.

It significantly simplifies the LED lighting system design by eliminating the secondary side feedback components and the opto-coupler, and also the auxiliary winding inductance. A HV 600V power switch is also integrated into the device. The LED current can be adjusted externally by the sense resistor R_s at CS pin and high precision constant current regulation is realized.

OB3652x offers comprehensive protection coverage with auto-recovery features including open loop protection, short circuit protection, cycle-by-cycle current limiting, built-in leading edge blanking, VDD under voltage lockout (UVLO), latched over temperature protection (OTP), etc.

OB3652x is offered in SOP-8 or DIP8 packages.

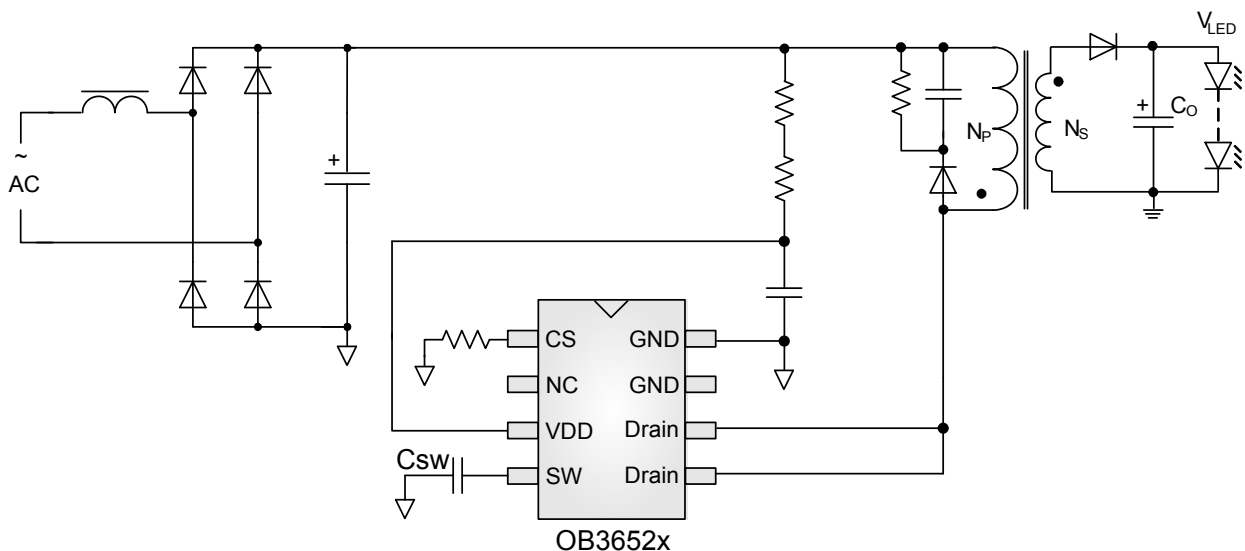
FEATURES

- High precision Constant Current Regulation at Universal AC input
- Primary-side Sensing and Regulation Without TL431 and Opto-coupler
- Sense and supply without auxiliary winding inductance
- Low System Cost and High Efficiency
- Low operation current
- Programmable CC Regulation
- Built-in Primary winding inductance compensation
- Built-in line compensation
- Short Circuit Protection
- Open Loop Protection
- Cycle-by-Cycle Current Limiting
- Built-in Leading Edge Blanking (LEB)
- VDD Under Voltage Lockout with Hysteresis
- Latched over temperature protection (OTP)

APPLICATIONS

- LED lighting

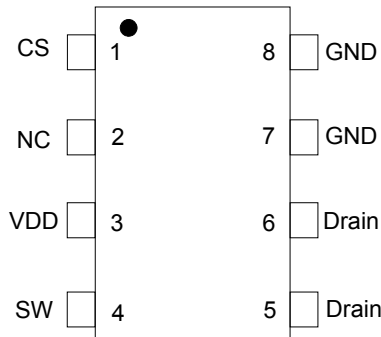
TYPICAL APPLICATION



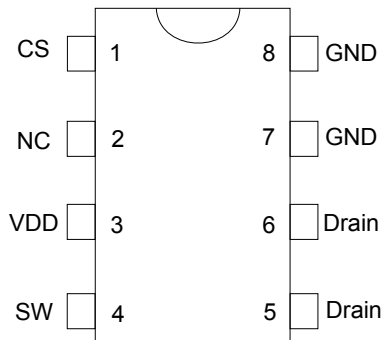
Note: The suggested range of C_{sw} is 47pF to 200pF.

GENERAL INFORMATION

Pin Configuration SOP-8



DIP-8



Ordering Information

Part Number	Description
OB3652SCP-H	8 Pin SOP, Halogen-free in Tube
OB3652SCPA-H	8 Pin SOP, Halogen-free in T&R
OB3652MCP-H	8 Pin SOP, Halogen-free in Tube
OB3652MCPA-H	8 Pin SOP, Halogen-free in T&R
OB3652NAP	8 Pin DIP, Halogen-free in Tube
OB3652NCP	8 Pin SOP, Halogen-free in Tube
OB3652NCPA	8 Pin SOP, Halogen-free in T&R
OB3652YCP	8 Pin SOP, Halogen-free in Tube
OB3652YCPA	8 Pin SOP, Halogen-free in T&R
OB3652PAP	8 Pin DIP, Halogen-free in Tube
OB3652NCP-V	8 Pin SOP, Halogen-free in Tube
OB3652NCPA-V	8 Pin SOP, Halogen-free in T&R
OB3652PAP-H	8 Pin DIP, Halogen-free in Tube

Note: All Devices are offered in Halogen-free Package if not otherwise noted.

Package Dissipation Rating

Package	R θ JA (°C/W)
SOP-8	90
DIP-8	75

Recommended Operating Condition

Symbol	Parameter	Range
VDD	VDD Supply Voltage	8 to 10.5V

Absolute Maximum Ratings

Parameter	Value	
VDD Voltage	-0.3 to 20V	
DRAIN Voltage	OB3652M/S/N/P-H	-0.3 to 650V
	OB3652N/Y/P	-0.3 to 600V
	OB3652NCP-V	-0.3 to 700V
CS Input Voltage	-0.3 to 7V	
SW Input Voltage	-0.3 to 20V	
Min/Max Operating Junction Temperature T _J	-40 to 150 °C	
Operating Ambient Temperature T _A	-40 to 85 °C	
Min/Max Storage Temperature T _{stg}	-55 to 150 °C	
Lead Temperature (Soldering, 10secs)	260 °C	

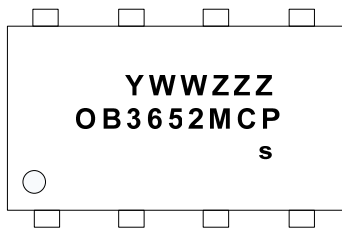
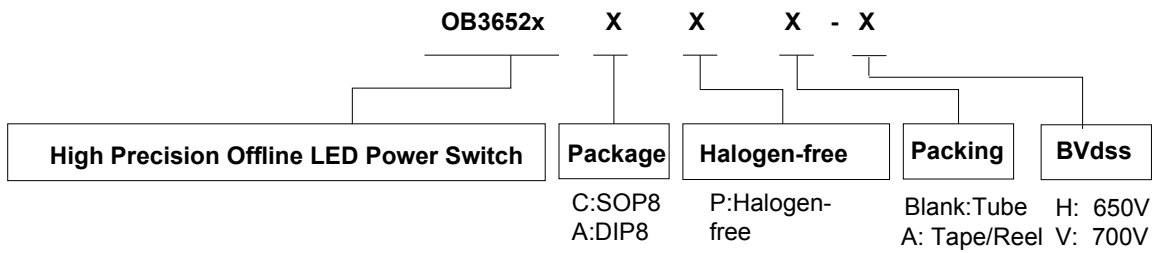
Note: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

Output Power Table

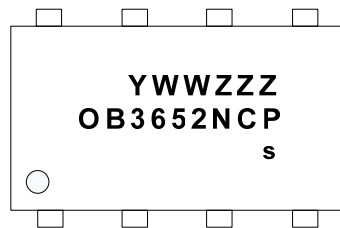
Product	90Vac~264Vac Input	220Vac±20% Input
OB3652SCP	3.1W	3.5W
OB3652MCP	5.5W	5.8W
OB3652NAP	9W	13W
OB3652NCP	6.7W	7.3W
OB3652YCP	9W	12W
OB3652PAP	12.5W	18W
OB3652NCP-V	8W	12W
OB3652PAP-H	12W	18W

Notes: Maximum practical continuous power in an open frame design with sufficient drain pattern as a heat sink, at 50°C ambient and 60°C temperature rise. Higher output power is possible with extra added heat sink or air circulation to reduce thermal resistance.

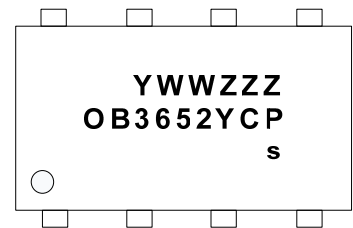
Marking Information



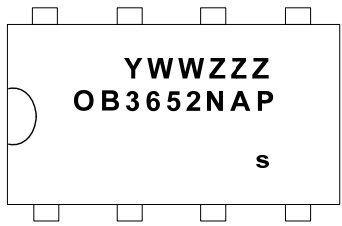
Y: Year Code
 WW: Week Code (01-52)
 ZZZ:Lot Code
 C: SOP8
 P:Halogen-free Package
 S: Internal Code(Optional)



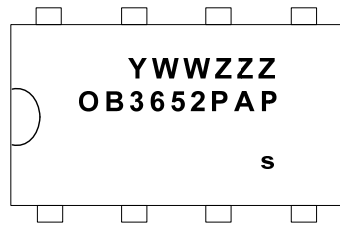
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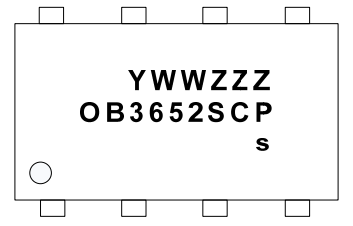
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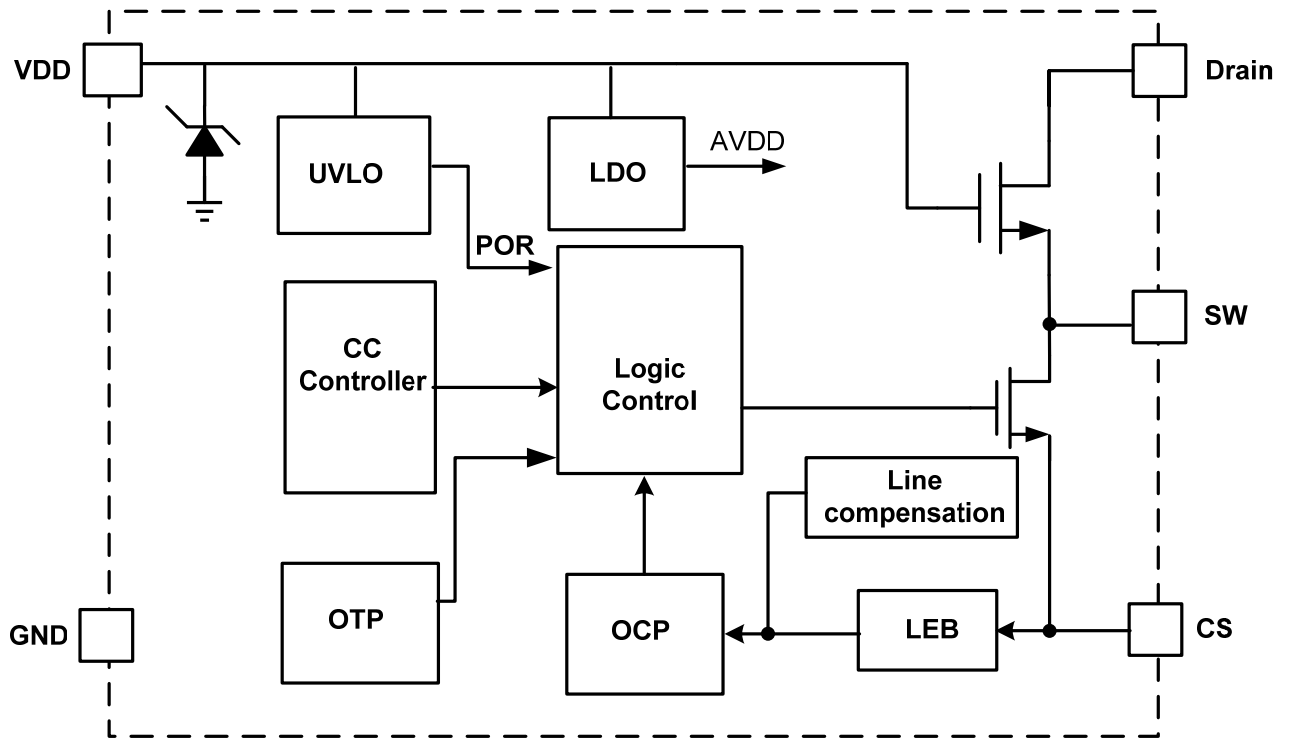
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TERMINAL ASSIGNMENTS

Pin Num.	Pin Name	I/O	Description
1	CS	I	Current sensing terminal
2	NC		No Connection
3	VDD	P	Power supply Input
4	SW	I	MOSFET Source Terminal
5,6	DRAIN	I	MOSFET Drain Terminal
7	GND	P	Power Ground, suggest to be left floating with no pad in PCB layout.

8	GND	P	Power Ground
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BLOCK DIAGRAM



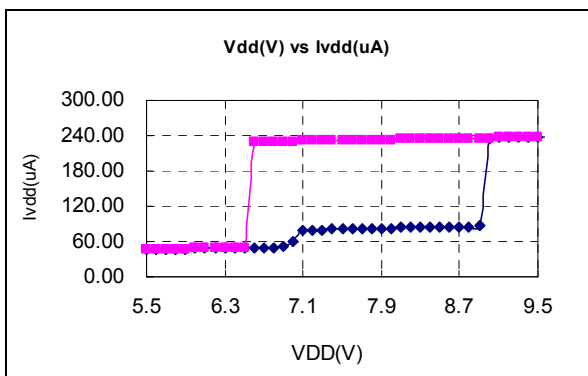
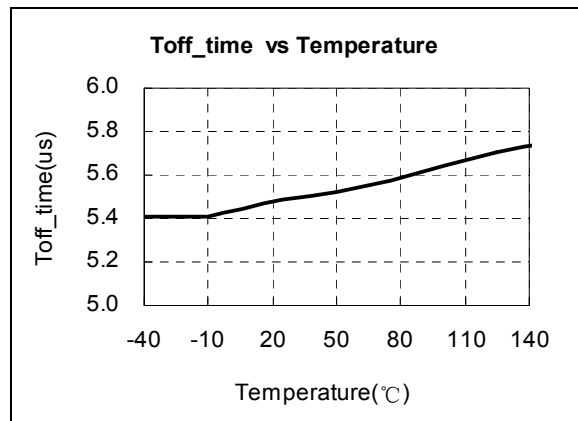
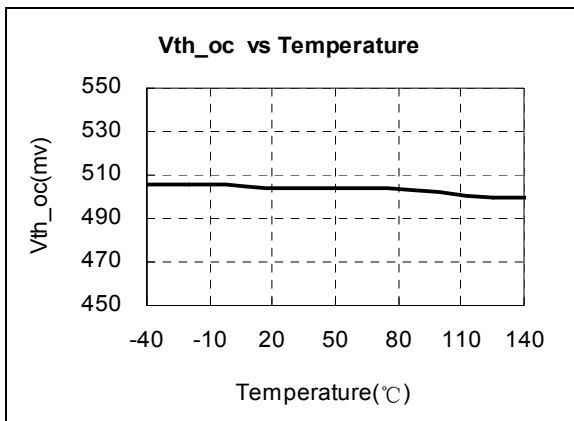
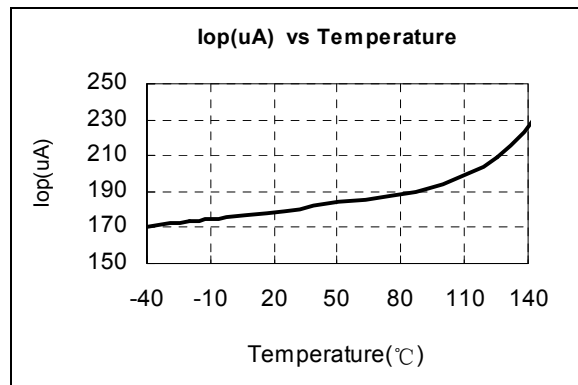
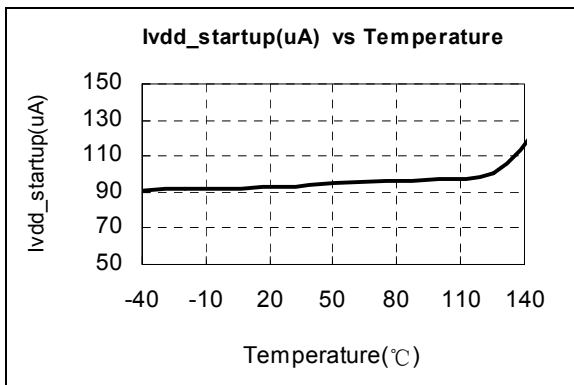
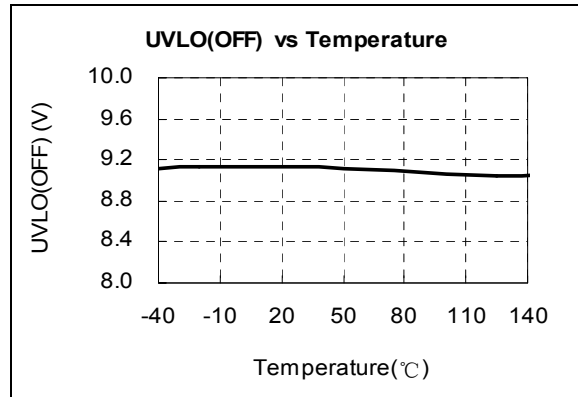
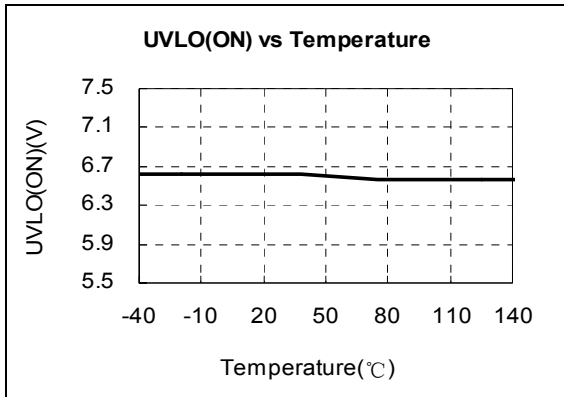
ELECTRICAL CHARACTERISTICS

(TA = 25°C, VDD=7.5V, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD) Section						
I _{start-up}	Start up current	VDD=UVLO(OFF)-1V		100	150	uA
I _{op}	Operation current	VDD=7.5V, no loading		190	250	uA
UVLO(OFF)	VDD under voltage lockout exit			9		V
UVLO(ON)	VDD under voltage lockout enter			6.5		V
VDD_CLAMP	VDD CLAMP	VDD current 1mA		10.5		V
Current Sense Input Section						
TLEB	LEB time			0.3		us
Vth_ocp	Over current threshold		485	500	515	mV
Td_oc	OCP propagation delay	From OCP comparator to gate drive		100		ns
Toff_max	Maximum off time			600		us
Toff_min	Minimum off time			5.5		us
Ton_max	Maximum on time			75		us
OTP Section						
OTP	Over temperature protection			150		°C

Parameter Product	BVdss(V) MOSFET Drain-Source Breakdown Voltage		
	Min	Typ.	Max
OB3652SCP	650		
OB3652MCP	650		
OB3652NAP	600		
OB3652NCP	600		
OB3652YCP	600		
OB3652PAP	600		
OB3652NCP-V	700		
OB3652PAP-H	650		

CHARACTERIZATION PLOTS



OPERATION DESCRIPTION

OB3652x is a primary side control offline LED lighting controller with very low operation current which can achieve accurate LED current for an isolated lighting application in a single stage converter. It significantly simplifies the LED lighting system design by eliminating the secondary side feedback components and the opto-coupler, and also the auxiliary winding inductance. A HV 600V power switch is also integrated into the device.

- **Start up Control**

Startup process is realized by charging VDD capacitor. When VDD voltage reaches up to UVLO(OFF), the inner circuit works. An 10.5V (typical) clamp circuit is designed to clamp VDD voltage. At work state, no auxiliary winding inductance is necessary.

- **Adjustable CC point**

In OB3652x, the CC point can be externally adjusted by external current sense resistor R_s at CS pin as illustrated in typical application diagram. The larger R_s is, the smaller CC point is, and vice versa.

- **Principle of CC Operation**

For flyback operating in DCM, the output current I_{out} is given by

$$I_{out} = \frac{1}{2} L_p F_{sw} I_p^2 \eta / V_{out} \quad (1)$$

Where L_p indicates the inductance of primary winding and I_p is the peak current of primary winding.

Refer to the equation 1, the change of the primary winding inductance results in the change of the constant output current. To compensate the change from variations of primary winding inductance, the switching frequency is locked by an internal loop such that the switching frequency is

$$F_{sw} = \frac{1}{2T_{Demag}} \quad (2)$$

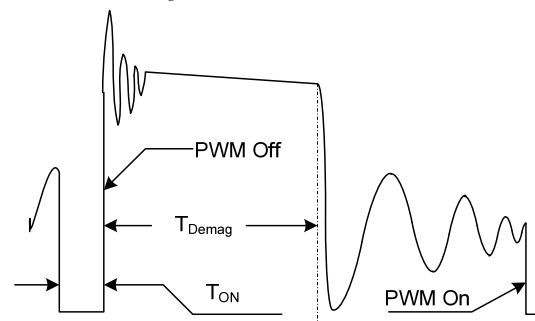


Figure.1 Drain voltage waveform

Since T_{Demag} is inversely proportional to the inductance, as a result, the product L_p and f_{sw} is constant, thus output current will not change as primary winding inductance changes. Up to $\pm 10\%$ variation of the primary winding inductance can be compensated.

The output LED current is

$$I_{out} = \frac{1}{4} N \frac{V_{thoc}}{R_s} \quad (3)$$

Where N is the ratio of transformer between primary-side winding and secondary winding.

- **Current Sensing and Leading Edge Blanking**

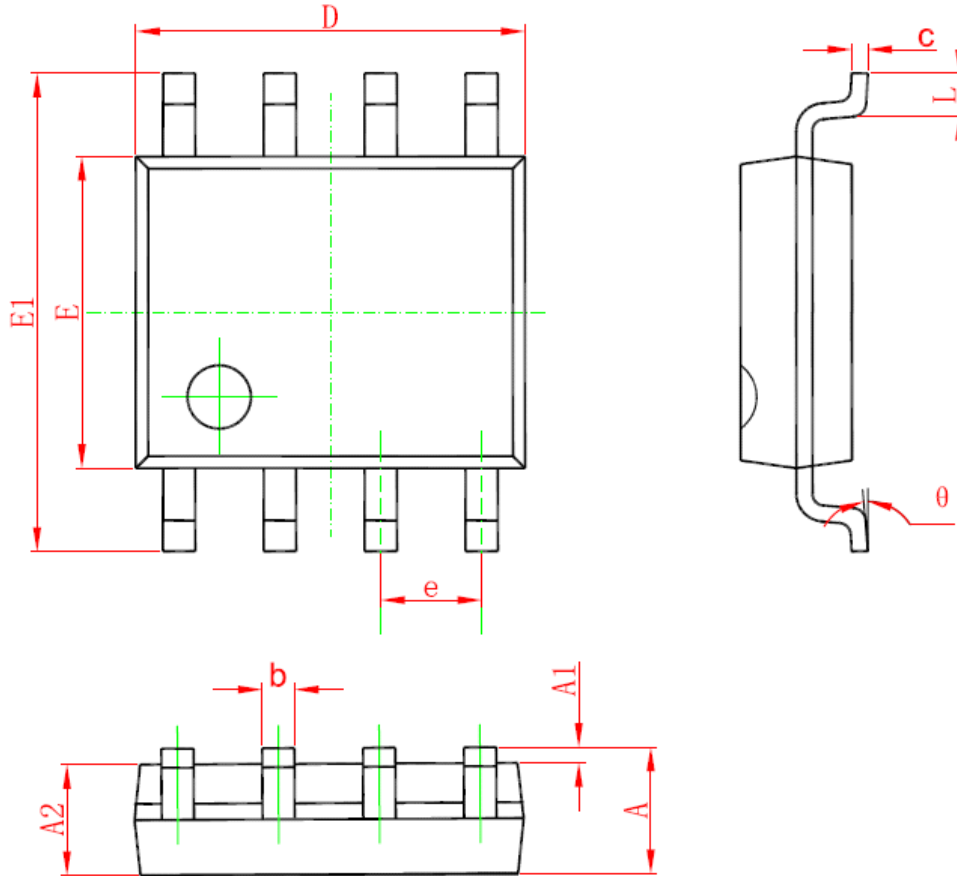
Cycle-by-Cycle current limiting is offered in OB3652x. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial power MOSFET on state.

- **Latched Over Temperature Protection**

Over temperature protection is offered in OB3652x. When temperature of the device rises over 150°C (typical), the switching frequency will decrease to half. And the state will be kept until the device restarts.

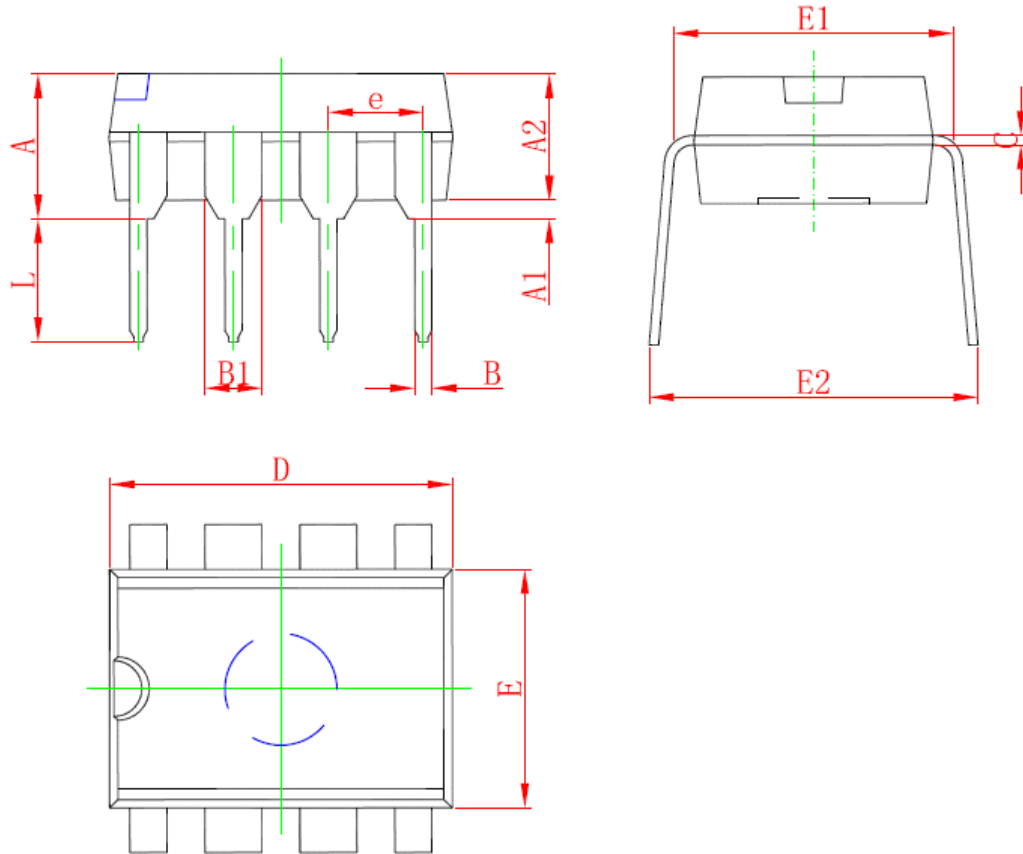
PACKAGE MECHANICAL DATA

SOP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	4.700	5.150	0.185	0.203
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

DIP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	5.334	0.146	0.210
A1	0.381		0.015	
A2	2.921	4.953	0.115	0.195
B	0.350	0.650	0.014	0.026
B1	1.524 (BSC)		0.06 (BSC)	
C	0.200	0.360	0.008	0.014
D	9.000	10.160	0.354	0.400
E	6.096	7.112	0.240	0.280
E1	7.320	8.255	0.288	0.325
e	2.540 (BSC)		0.1 (BSC)	
L	2.921	3.810	0.115	0.150
E2	7.620	10.920	0.300	0.430

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